Patent Claims

1. A method for energy-saving operation of a dishwasher (110; 410), in particular for washing dishes (9; 414) or medical appliances, with the dishwasher (110; 410) having a total number $N \geq 2$ of electrical load elements (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438), having the following steps:

a) a group of n electrical load elements (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) is assigned a maximum electrical total power p_{max};

b) each electrical load element i in the group of n electrical load elements (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) is assigned a finite number m_i of discrete electrical power levels p_{ij} where $m_i \geq 2$:

- with there being a maximum power level p_{imax} for each i, where $p_{ij} \leq p_{imax}$,
- where the sum of all maximum power levels p_{imax} form a worst total power $p_{worst} = \sum_{i=1}^{n} p_{imax}$ where $p_{max} < p_{worst}$, and
- where a regular power level p_{ireg} exists for each i, where $0 < p_{ireg} < p_{imax}$ for all i, j, and where $\sum_{i=1}^{n} p_{ireg} = p_{max}$;

c) an optimum combination of power levels $p_{ij}(B)$ is selected in a demand determination step, as a function of an operating state B of the dishwasher (110; 410),

- where the selected power level $p_{ij}(B)$ for each i is matched to the power demand of the load element i (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) in the operating state B, and
- where: $\sum_{i=1}^{n} p_{ij}(B) \leq p_{max}$, for all operating states B; and

d) the electrical power of each load i in the group of n electrical load elements (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) is set to the power level $p_{ij}(B)$.

2. The method as claimed in the preceding claim, characterized in that a power level p_{ik} exists for each electrical load i (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438), where $0 < k \leq m_i$ and where $p_{ik} = 0$.

3. The method as claimed in one of the two preceding steps, characterized in that $m_i = 3$ for all i.

4. The method as claimed in one of the preceding claims, characterized in that the following method steps are additionally carried out:

e) the dishwasher (110; 410) is started, as a result of which a starting phase begins;

f) at least one temperature of at least one washing liquid, in particular a temperature of water in at least one water tank (13, 17, 21; 416, 426) and/or water circuit, is detected;

g) the at least one washing liquid is heated,

- where at least one heating element (14, 18, 22, 26; 418, 432) which heats the washing liquid and forms the load element l where $l \in \{1,...,n\}$ is operated at the maximum power level p_{lmax} associated with this heating element (14, 18, 22, 26; 418, 432), and
- where at least one load element q (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) which is not the same as the heating element (14, 18, 22, 26; 418, 432) and where $q \in \{1,...,n\}$ and $q \neq 1$ is operated at a lower power than the regular power level p_{qreg} associated with this load element q (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438); and

h) as soon as the at least one temperature of the at least one washing liquid has reached or exceeded a predetermined nominal value, a switched-on phase is started,

- where the power of all the load elements i (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) is set to the respectively associated regular power level p_{ireg}.

5. The method as claimed in the preceding claim, having the following additional step:

i) at least one operating state variable is detected;

j) at least one operating state variable is allocated a nominal value; and

k) as soon as the value of the at least one operating state variable differs from the respectively associated nominal value by more than a predetermined tolerance, a load regulation phase is started.

6. The method as claimed in the preceding claim, characterized in that, in the load regulation phase, at least one load element r (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) where $r \in \{1,...,n\}$ and which influences the at least one operating state variable which differs by more than the predetermined tolerance from its nominal value is operated at a power level which differs from its regular power level p_{rreg}, until the at least one operating state variable once again assumes a value which differs by not more than the predetermined tolerance from its nominal value.

7. The method as claimed in one of the preceding claims, characterized in that, in method step c), each load element (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) is allocated a priority, and

in that the optimum combination of the power levels pij(B) is determined taking into account the priorities of the load elements (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438).

8. The method as claimed in the preceding claim, characterized in that heating elements (14, 18, 22; 418, 432) which heat washing liquid, in particular water in at least one water tank (13, 17, 21; 416, 426) and/or water circuit, is allocated a higher priority than other loads.

9. The method as claimed in one of the preceding claims, characterized in that all of the operating states B are characterized by an operating phase variable F and/or by a plurality of operating state variables,

- where the operating state variable F can assume at least three discrete values (F_1, F_2, F_3),
- where F_1 denotes a starting phase for operation of the dishwasher (110; 410),
- where F_2 denotes a switched-on phase for operation of the dishwasher (110; 410), and
- where F_3 denotes the load regulation phase for operation of the dishwasher (110; 410).

10. An apparatus for energy-saving operation of a dishwasher (110; 410), in particular for washing dishes (9; 414) or medical appliances, with the dishwasher (110; 410) having a total number $N \geq 2$ of electrical load elements (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438), having:

a) means (310) for assignment of a maximum electrical total power p_{max} to a group of n electrical load elements (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438);

b) means (310, 332, 334, 336, 338, 340; 452, 454, 456, 458) for assignment of a finite number m_i

of discrete electrical power levels p_{ij} to each electrical load element i in the group of n electrical load elements (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438),

- with there being a maximum power level p_{imax} for each i, where $p_{ij} \leq p_{max}$,
- where the sum of all maximum power levels p_{imax} form a worst total power $p_{worst} = \sum_{i=1}^{n} p_{imax}$ where $p_{max} < p_{worst}$, and
- where a regular power level p_{ireg} exists for each i, where $0 < p_{ireg} < p_{imax}$ for all i, j, and where $\sum_{i=1}^{n} p_{ireg} = p_{max}$;

c) means (310) for selection of an optimum combination of power levels $p_{ij}(B)$, as a function of an operating state B of the dishwasher (110; 410),

- where the selected power level $p_{ij}(B)$ for each i is matched to the power demand of the load element i (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) in the operating state B, and
- where: $\sum_{i=1}^{n} p_{ij}(B) \leq p_{max}$, for all operating states B; and

d) means (310, 322, 324, 326, 328, 330, 332, 334, 336, 338, 340; 444, 446, 448, 450, 452, 454, 456, 458) for setting the electrical power of each load i (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) in the group of n electrical load elements (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) to the respective power level $p_{ij}(B)$.

11. The apparatus as claimed in the preceding claim, additionally having:

e) means (310) for starting the dishwasher (110; 410) by which means a starting phase is started;

f) means (318, 320) for detection of at least one temperature of at least one washing liquid, in particular a temperature of water in at least one water tank (13, 17, 21; 416, 430) and/or water circuit;

g) at least one heating element (14, 18, 22, 26; 418, 432), which heats the at least one washing liquid and forms the load element l (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) where $l \in \{1,...,n\}$, as well as means (322, 324, 326, 328; 448, 450) for operation of the at least one heating element (14, 18, 22, 26; 418, 432) at the maximum power level p_{lmax} associated with this heating element, as well as means (322, 324, 326, 328, 330; 444, 446, 448, 450) for operation of at least one load element q (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438), which is not the same as the at least one heating element, where $q \in \{1,...,n\}$ and $q \neq 1$ at a lower power than the regular power level p_{qreg} associated with this load element q (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438); and

h) means (310) for starting a switched-on phase as soon as the at least one temperature of the at least one washing liquid has reached or exceeded a predetermined nominal value,

- where the power of all the load elements i (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) is set to the respectively associated regular power level p_{ireg}.

12. The apparatus as claimed in the preceding claim, additionally having:

i) means (318) for detection of at least one operating state variable;

l) means (310) for assignment of in each case one nominal value to at least one operating state variable; and

m) means (310) for starting a load regulation phase as soon as the value of the at least one operating state variable differs by more than a predetermined tolerance from the respectively associated nominal value.

13. The apparatus as claimed in the preceding claim, having additional means (322, 324, 326, 328, 330; 444, 446, 448, 450) for operation of at least one load element r (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) where $r \in \{1,...,n\}$ which influences the at least one operating state variable which differs by more than the predetermined tolerance from its nominal value at a power level, which differs from its regular power level p_{rreg}, in the load regulation phase, until the at least one operating state variable once again assumes a value which differs from its nominal value by not more than the predetermined tolerance.

14. The apparatus as claimed in one of the preceding apparatus claims, characterized in that the means c) (310) for selection of an optimum combination of power levels $p_{ij}(B)$ have means (310) for allocation of a priority to each load element (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) as a function of an operating state B of the dishwasher (110; 410), where the optimum combination of the power levels pij(B) is determined taking into account the priorities of the load elements (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438).

15. The apparatus as claimed in one of the preceding apparatus claims, characterized in that the dishwasher is a multiple tank dishwasher (110).

16. The apparatus as claimed in one of the preceding apparatus claims, characterized in that the means b) (310, 332, 334, 336, 338, 340; 452, 454, 456, 458) for assignment of a finite number mi of discrete electrical power levels pij to each electrical load element (14, 15, 18, 19, 22, 23, 26, 33; 418, 420, 432, 438) and/or the means c) (310) for selection of an optimum combination of power levels pij(B) as a function of an operating state B of the dishwasher (110; 410) have/has a look-up table (314) and/or an electronic table.

17. A computer program having program code means in order to carry out a method as claimed in one of the preceding method claims, when the computer program is run on a computer (310) or a computer network.

18. A computer program having program code means as claimed in the preceding claim, which program code means are stored on a computer-legible data storage medium (314).